Negation Modeling for German Polarity Classification

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Outline of Talk

- Introduction
- Data & Annotation
- Method
- Experiments
- Conclusion

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Polarity and Negation

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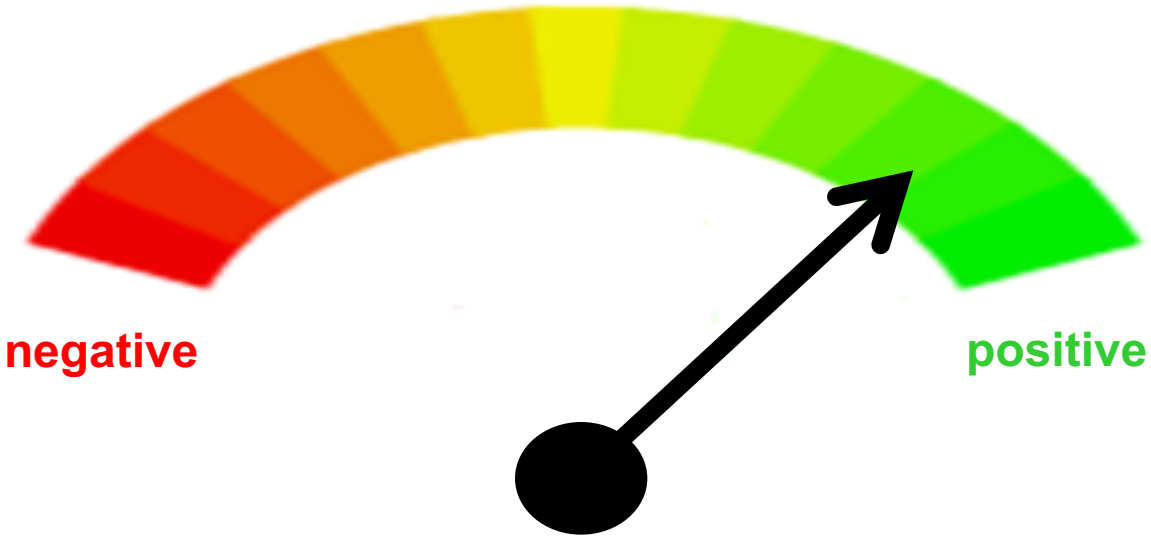
Polarity and Negation

I like blueberry muffins.

Polarity and Negation



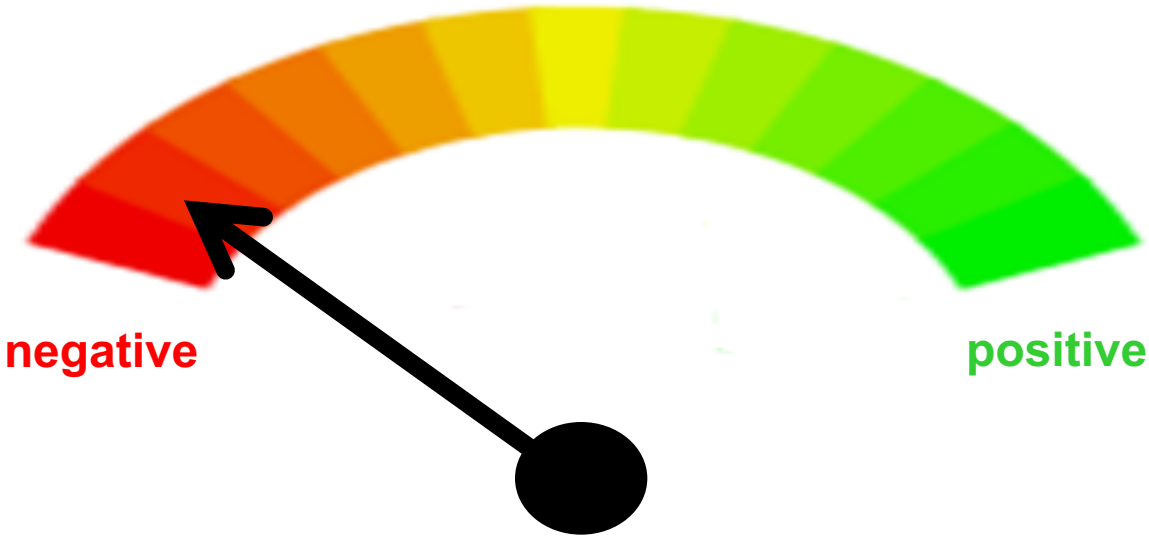
I like⁺ blueberry muffins.

positive polar expression

Polarity and Negation

Eating offal is disgusting.

Polarity and Negation



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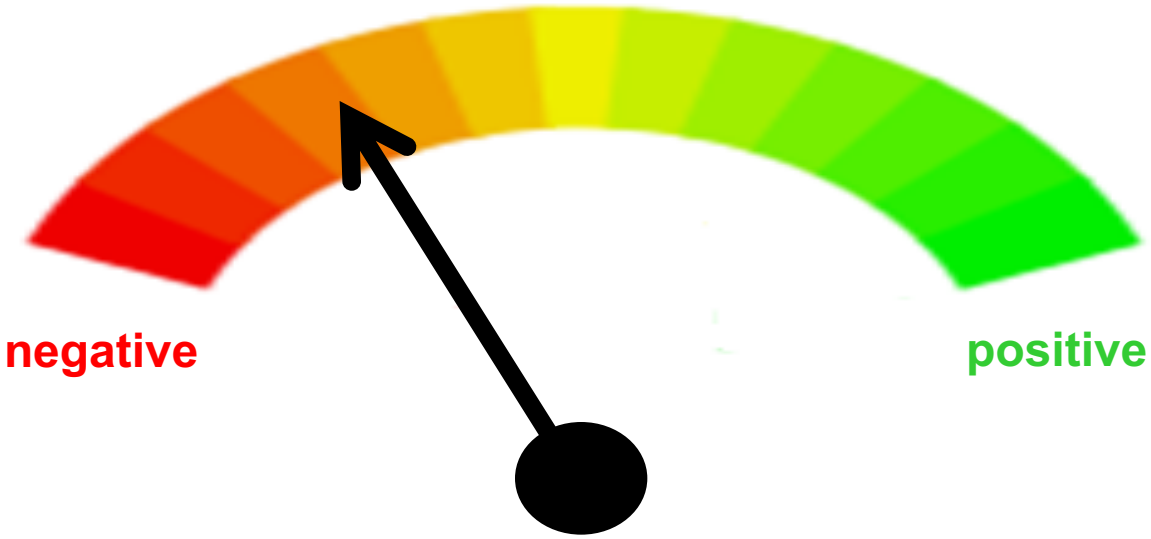
negative polar expression

Polarity and Negation



I don‘t like spinach muffins.

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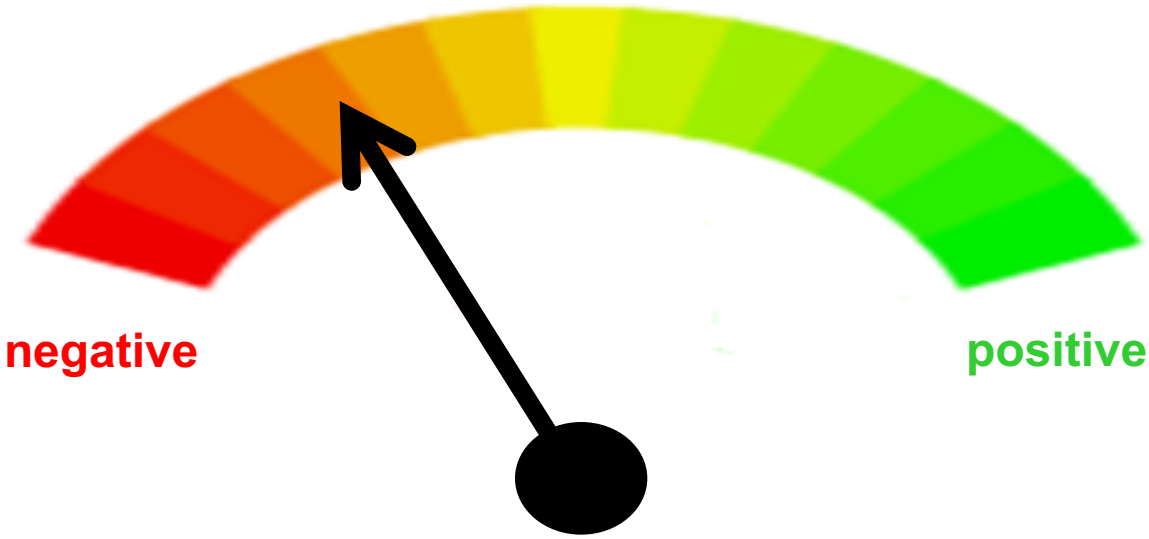

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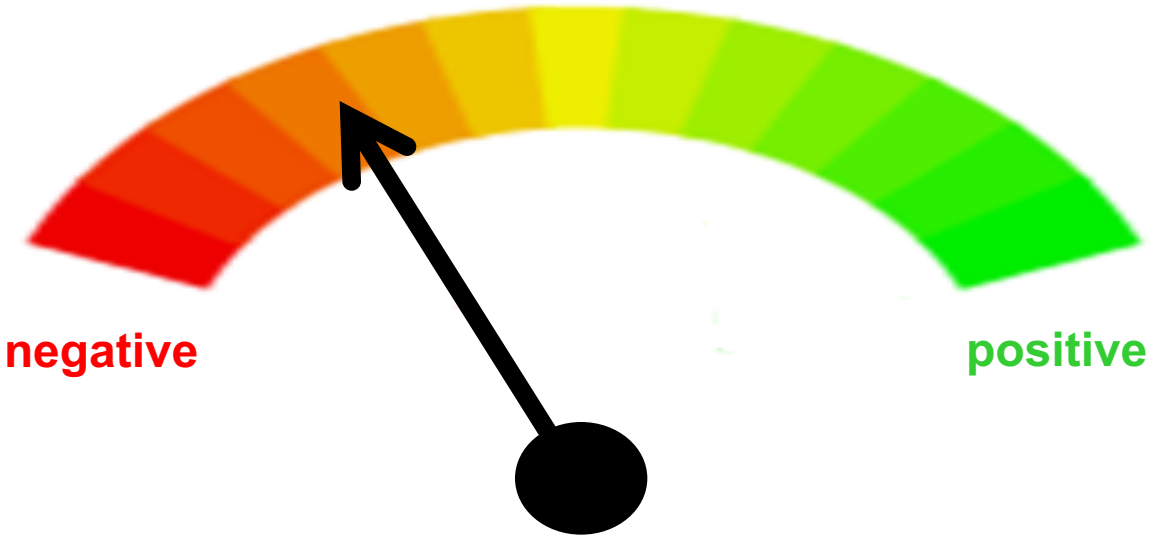
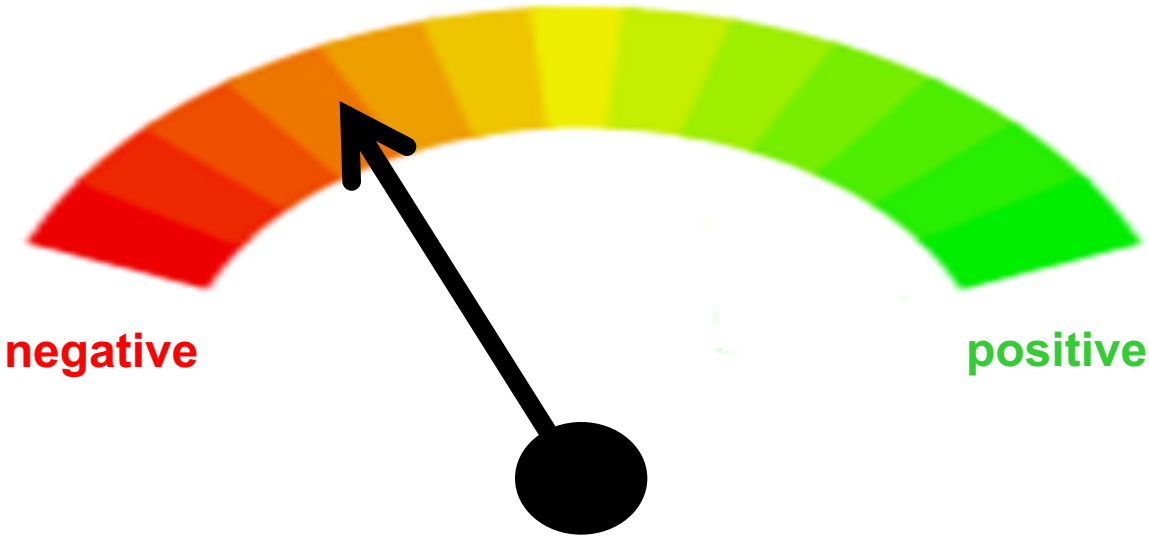


*I **don't** like⁺ spinach muffins.*

negation word

Polarity and Negation



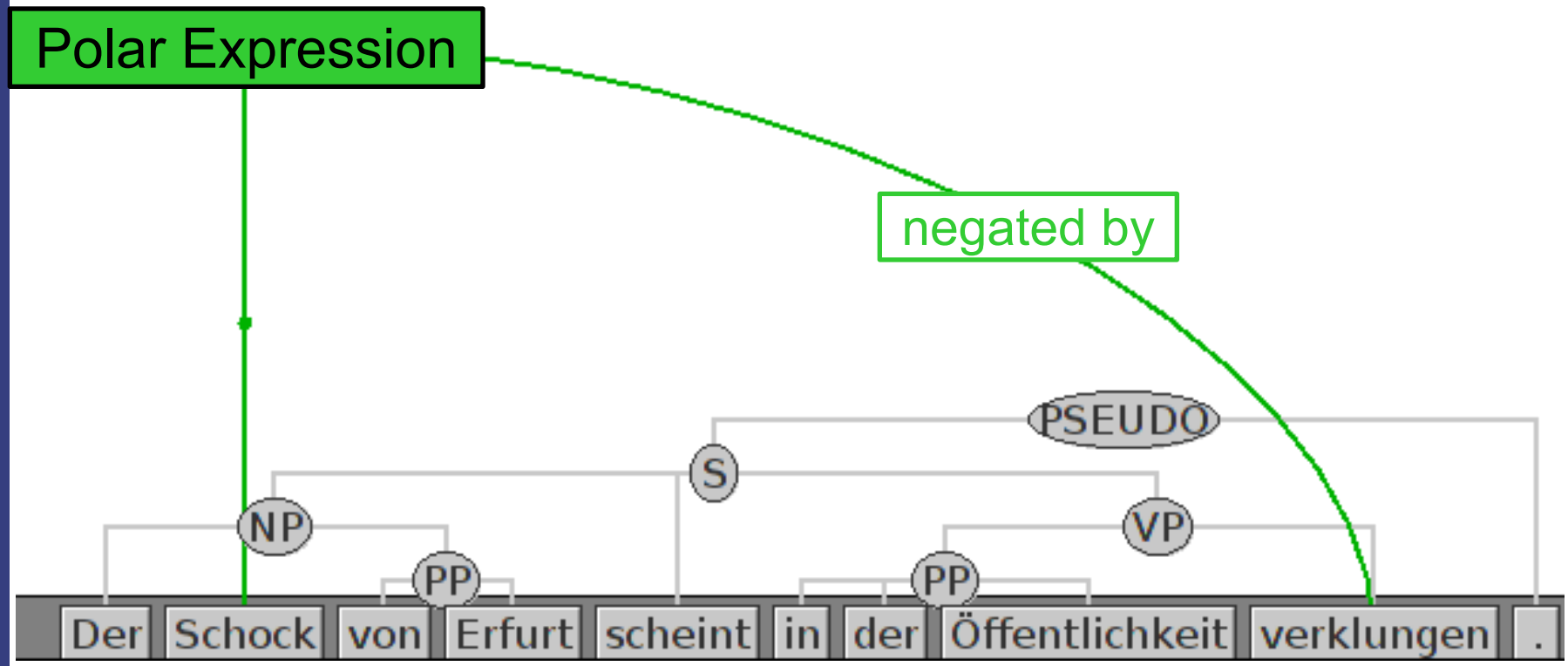
*I [**don't** like^{+}]$^{-}$ spinach muffins.*

Negation inverts the polarity of the polar expression.

In this Talk

- First comprehensive study on German negation modelling for fine-grained sentiment analysis.
- We consider various types of negation words beyond *nicht (not)* or *kein (no)* including
  - verbs: *[Angst^{-}* ***bannen***$]^{+}$ *([**banish** fear^{-}]$^{+}$)*
  - nouns: *[**Rückgang** an Fettsucht $^{-}$]$^{+}$ ([**drop** in obesity^{-}]$^{+}$)*
  - adjectives: *[**wenig** Hoffnung^{+}]$^{-}$ ([**little** hope^{+}]$^{-}$)*
- New dataset and software tool.

The Task Illustrated



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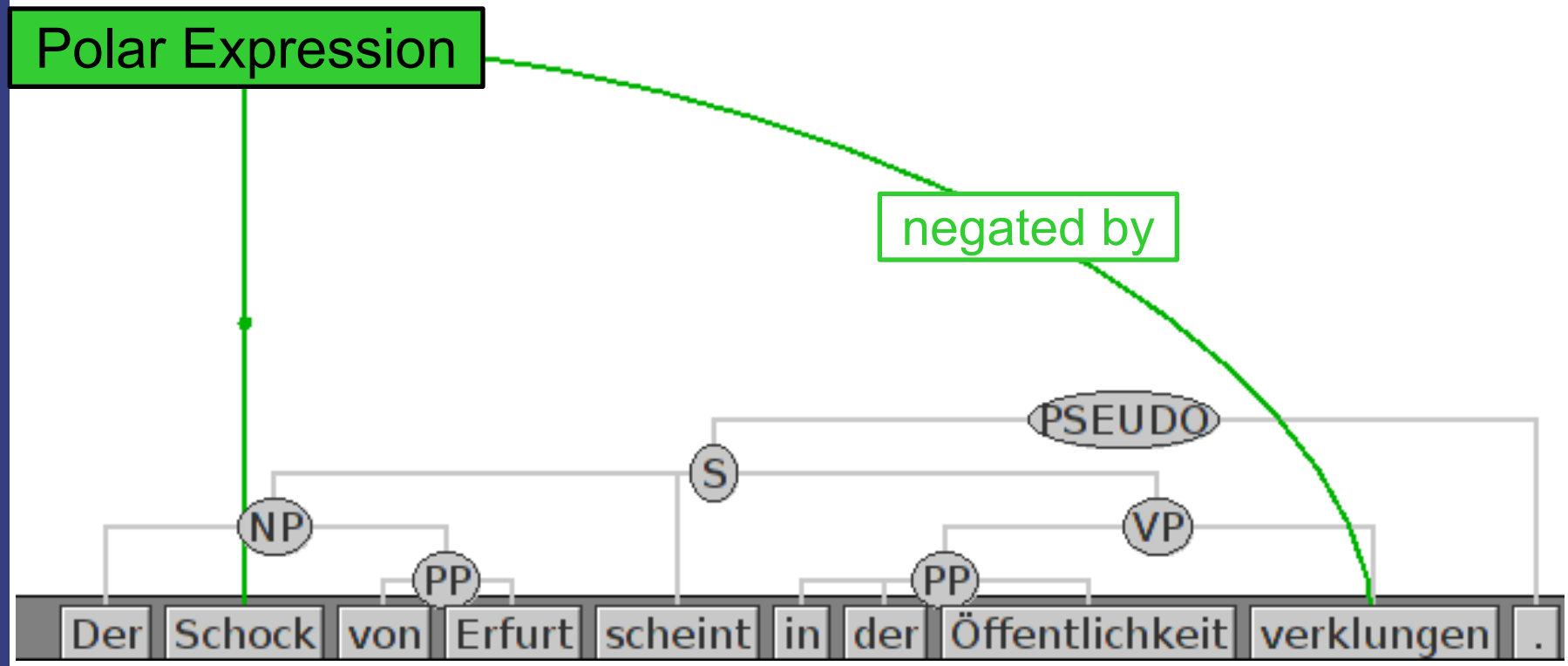

The shock of Erfurt seems to have faded away in the public.

What this work is about!

- Our work is **not** concerned about:
  - detecting subjective/polar expressions
  - detecting negation words
- Our task:
  - to **identify the scope** of a negation word, given that polar expression and negation word have already been identifed.

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Data

- 500 sentences sampled from DeWaC-corpus [Baroni, 2009].
- Each sentence contains at least one negation word and one polar expression.
- Remove incomplete/ungrammatical sentences.
- Annotate which polar expression is within the scope of a negation word.
- Agreement: Cohen‘s κ=0.87

Properties of Dataset

Property	Freq
number of sentences	433
number of polar expressions	979
number of sentences with negated polar exprs.	282
number of negation words *left* of polar expr.	142
number of negation words *right* of polar expr.	140

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The co-occurrence of polar expression and negation word does not imply a negated polar expression.

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German negation words have a scope over polar expressions occurring both left and right of them.

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Proposed Framework

- Rule-based approach.
- Group negation words with similar scope characteristics.
- For each group:
  - list the possible scopes as a list *(priority scope list)* of dependency relations.
- On the priority scope list: the first relation observed with the negation word is negated.

Proposed Framework

Negation Type	Examples	Priority Scope List
adverbs/indef. pronouns	*nie, kein, kaum*	clause
particle	*nicht*	governor
prepositions	*ohne, gegen*	dependent
adjectives	*weniger, gescheitert*	subj, $attr^{inv}$
nouns	*Abschaffung, Linderung*	gmod, objp-*
verbs	*ablegen, vermindern*	objg, obja, objd, objc, obji, objp-*, subj

Adverbs and Indefinite Pronouns

[**Kein** Kollege möchte ihm helfen^{+}]$^{-}$$_{\texttt{main-clause}}$,

weil er völlig unorganisiert ist.

(No colleague wants to help him because he is completely disorganized.)

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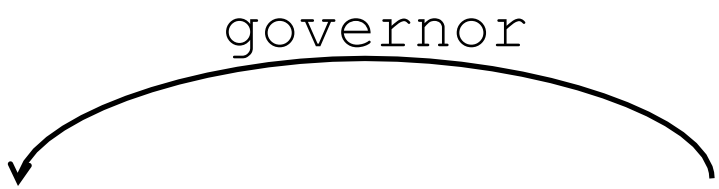
(No colleague wants to help him because he is completely disorganized.)

Notice: the negative polar expression in the adverbial clause is outside the scope of the negation word!

Negation Particle



Wir [unterstützen^{+} ihn dabei **nicht**]$^{-}$.

(We do not support him with that.)

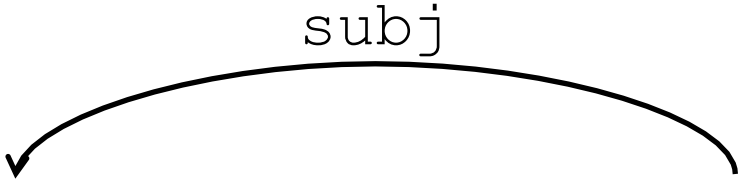
Prepositions

Wir schaffen eine Welt ganz [**ohne** Hass^{-}]$^{+}$.

(We create a world without hatred.)

Adjectives

predicate adjs.



[Diese Bemühungen^{+} sind **gescheitert**]$^{-}$.

(These efforts failed.)

Das macht [**weniger** Spaß$^{+}$]$^{-}$.

(This is less fun.)

Adjectives

subj

[Diese Bemühungen^{+} sind **gescheitert**]$^{-}$.

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attributive adjs.

attr

Das macht [**weniger** Spaß$^{+}$]$^{-}$.

(This is less fun.)

Nouns

Es dient zur [**Vorbeugung** vor Krankheiten^{-}]$^{+}$.

(It is used for preventing diseases.)

Das Gericht beschloss die [**Aufhebung** der Strafe^{-}]$^{+}$.

(The court decided to lift the sentence.)

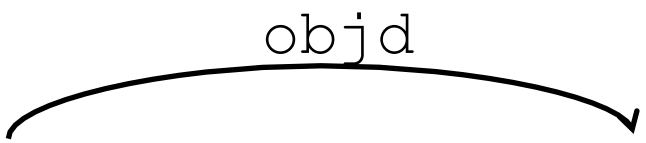
Verbs

- Verbs present the most complicated case.
- A large amount of argument positions are eligible:

  [objg, obja, objd, objc, obji, objp-, subj]*

- Here, the mechanism of the priority list is important.

Verbs



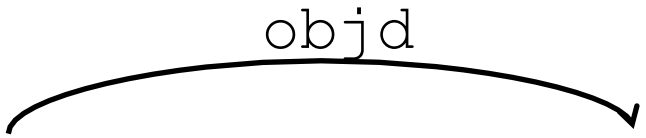
Die Menschheit [**entging** einer Katastrophe^{-}]$^{+}$.

(Mankind averted disaster.)

Das [**ersparte** uns viel Ärger^{-}]$^{+}$.

(This saved us a lot of trouble.)

Verbs



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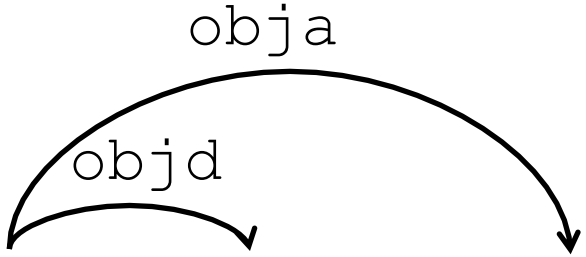

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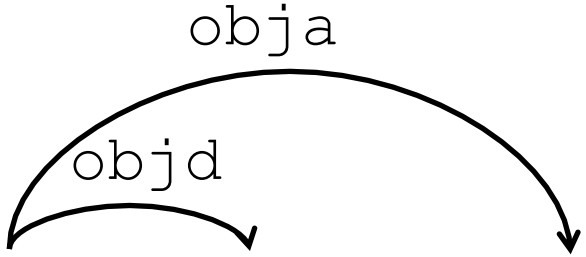
priority scope list:

`obja >> objd`



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Verbs

This mechanism can even account for word sense ambiguity.

Sie [**nahm** ihm eine große Last^{-} **ab**]$^{+}$.

(She took a great burden from him.)

[Seine Wut^{-} **nahm** deutlich **ab**]$^{+}$.

(His anger notably decreased.)

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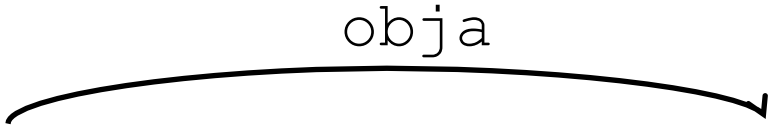

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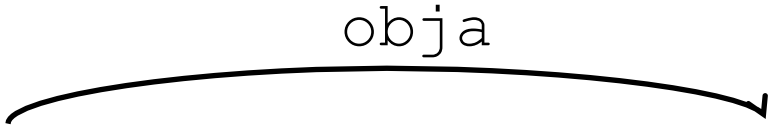

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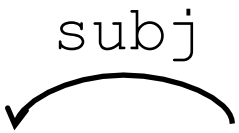

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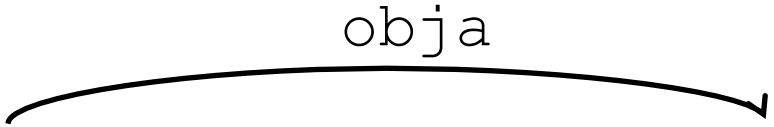

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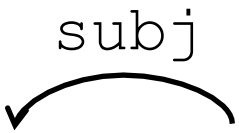

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Further Properties of Approach

- Heavily relies on fine-grained label inventory of dependency parser ParZu [Sennrich, 2009].
- We also allow modifiers of syntactic dependent to be within scope of negation.
- Normalize output of ParZu:
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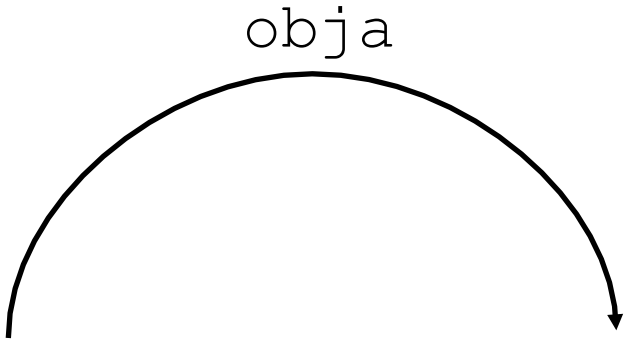

Die Regierung [**hob** unsinnige^{-} Gesetze **auf**]$^{+}$.

(The government repealed silly laws.)

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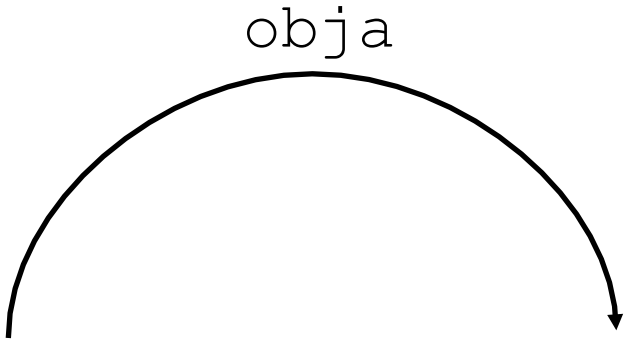

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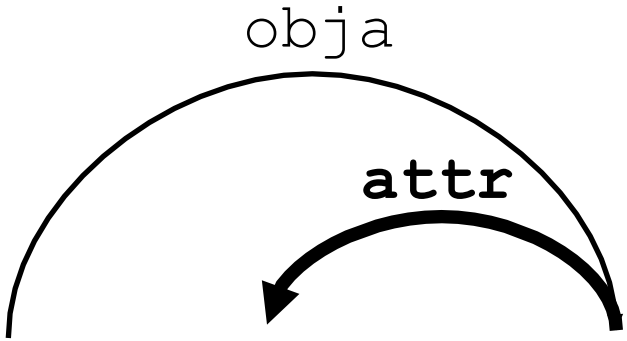

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- Modifier *unsinnig* is not grammatically related to *hob auf.*
- Allow mediate relationships.

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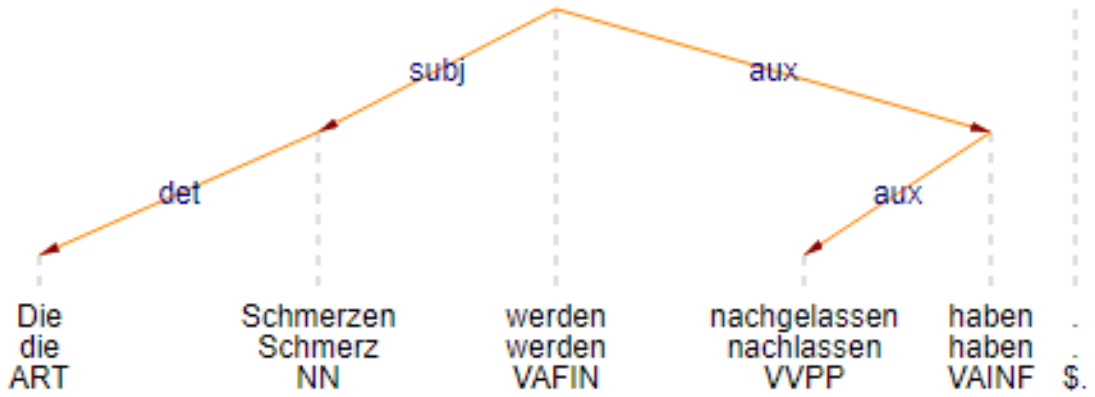
Tree Pruning



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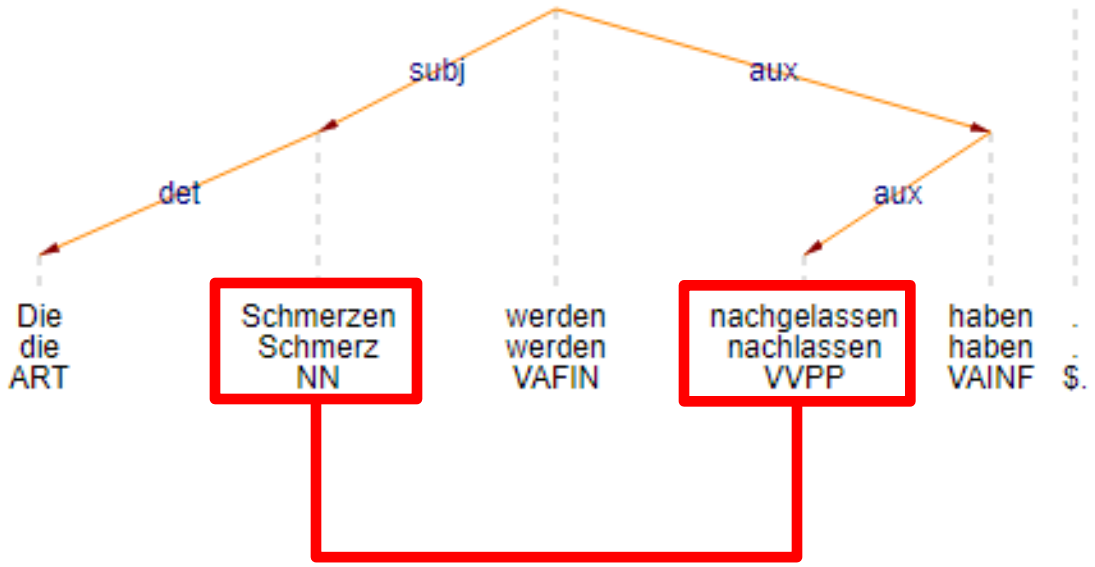

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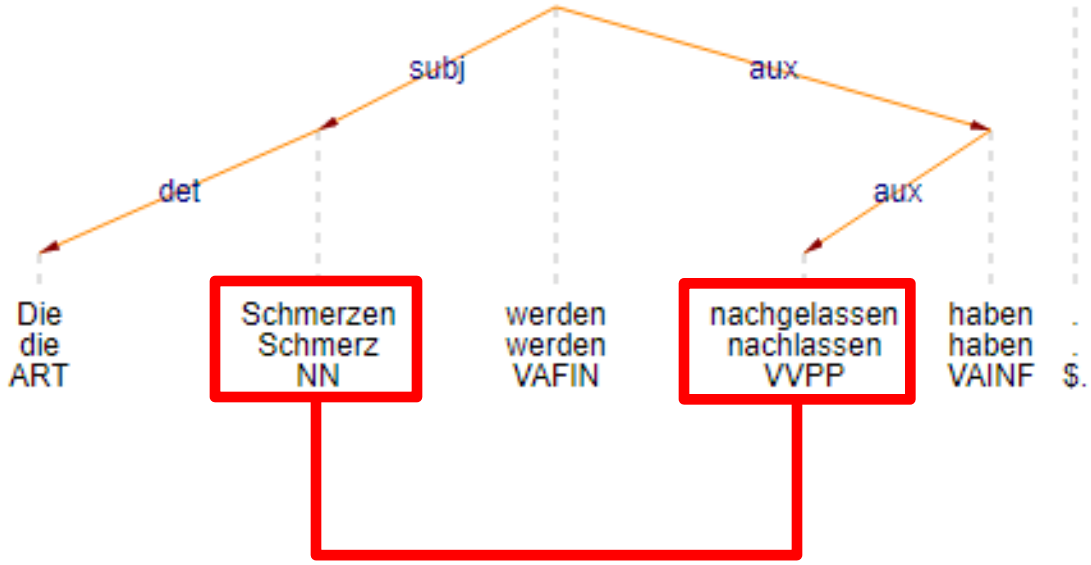

- There is no (direct) edge from the polar expression *Schmerz* to the negation verb *nachgelassen*.
- Remove nodes representing auxiliaries.

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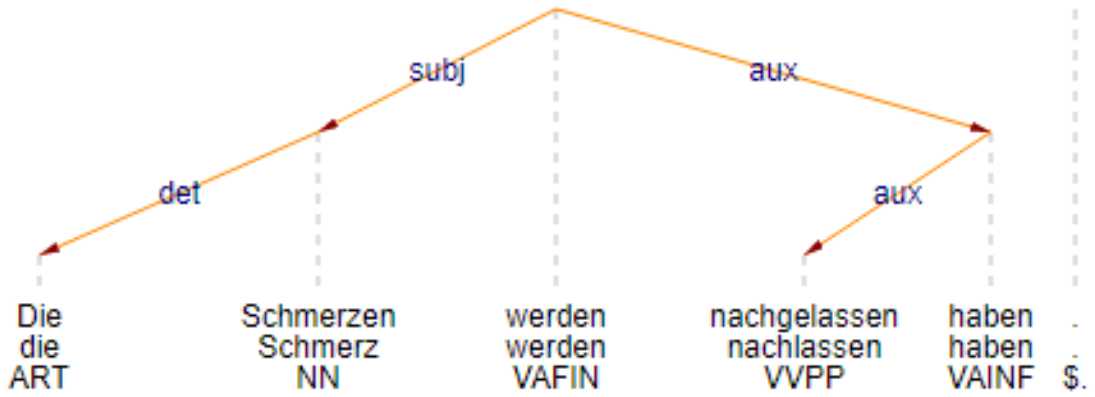

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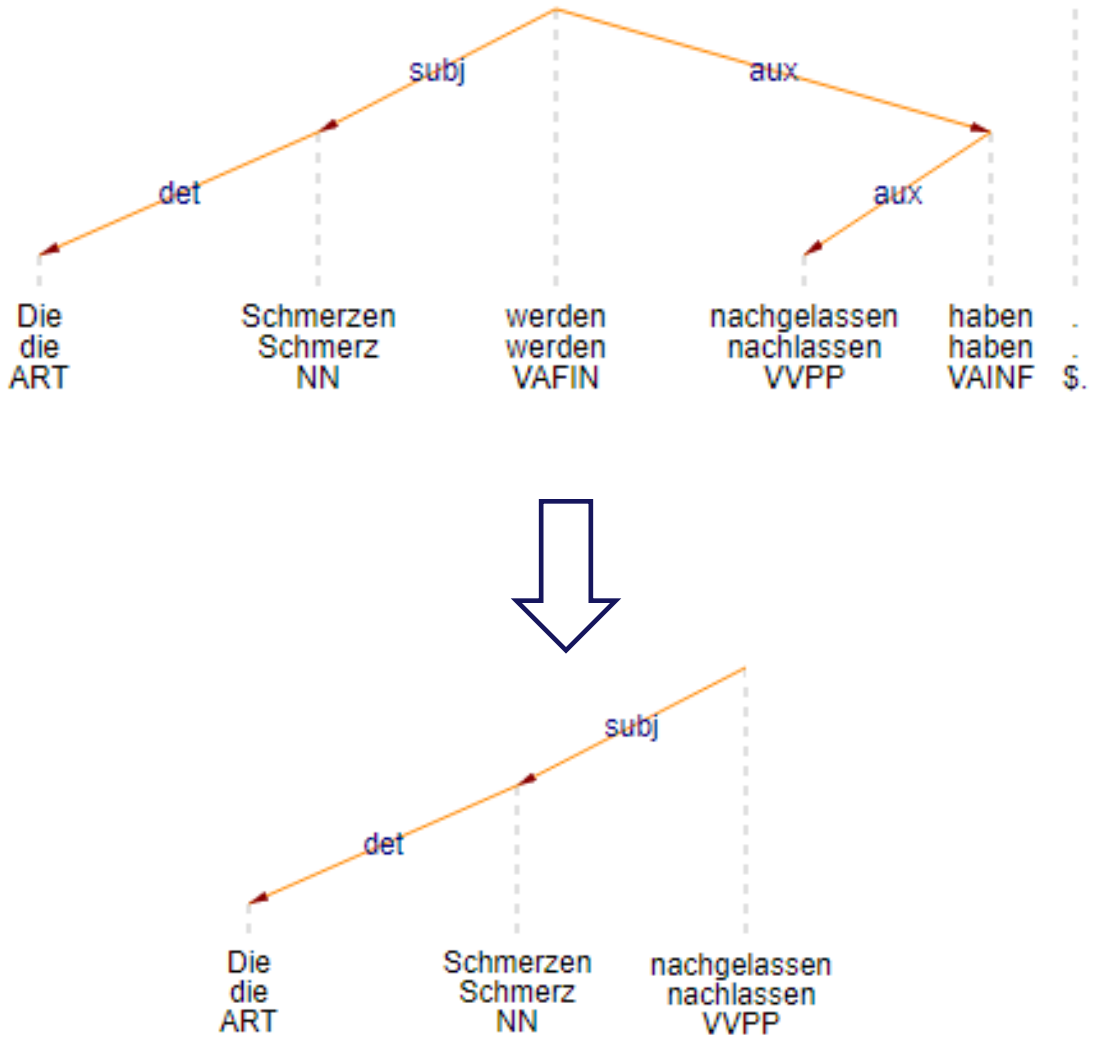

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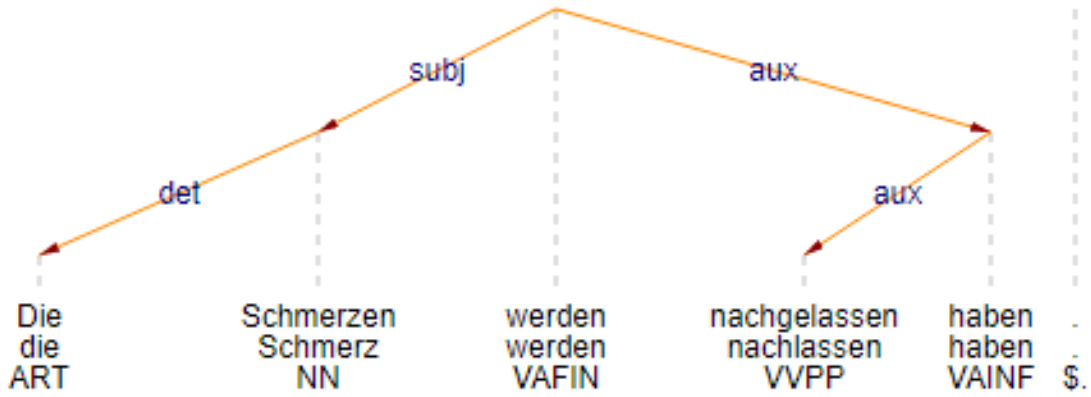

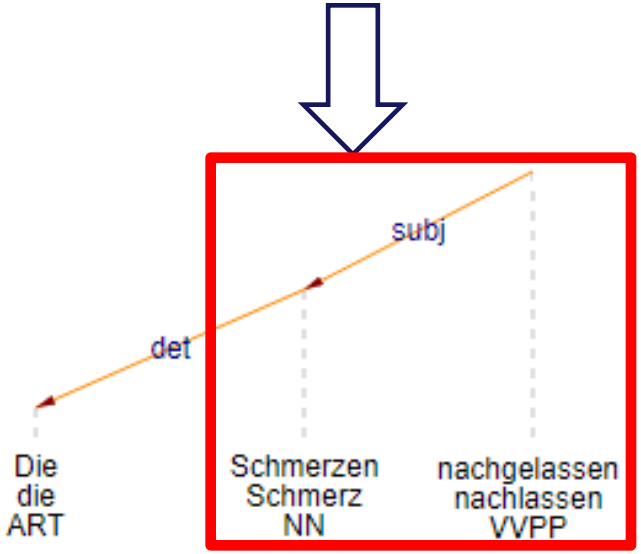

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Experimental Set-Up

- Evaluate on new dataset.
- Baselines:
  - **Window-based baseline**: consider *n* words around negation word as scope
  - **Clause-based baseline**: consider all words in clause in which negation word occurs as scope

Experimental Set-Up

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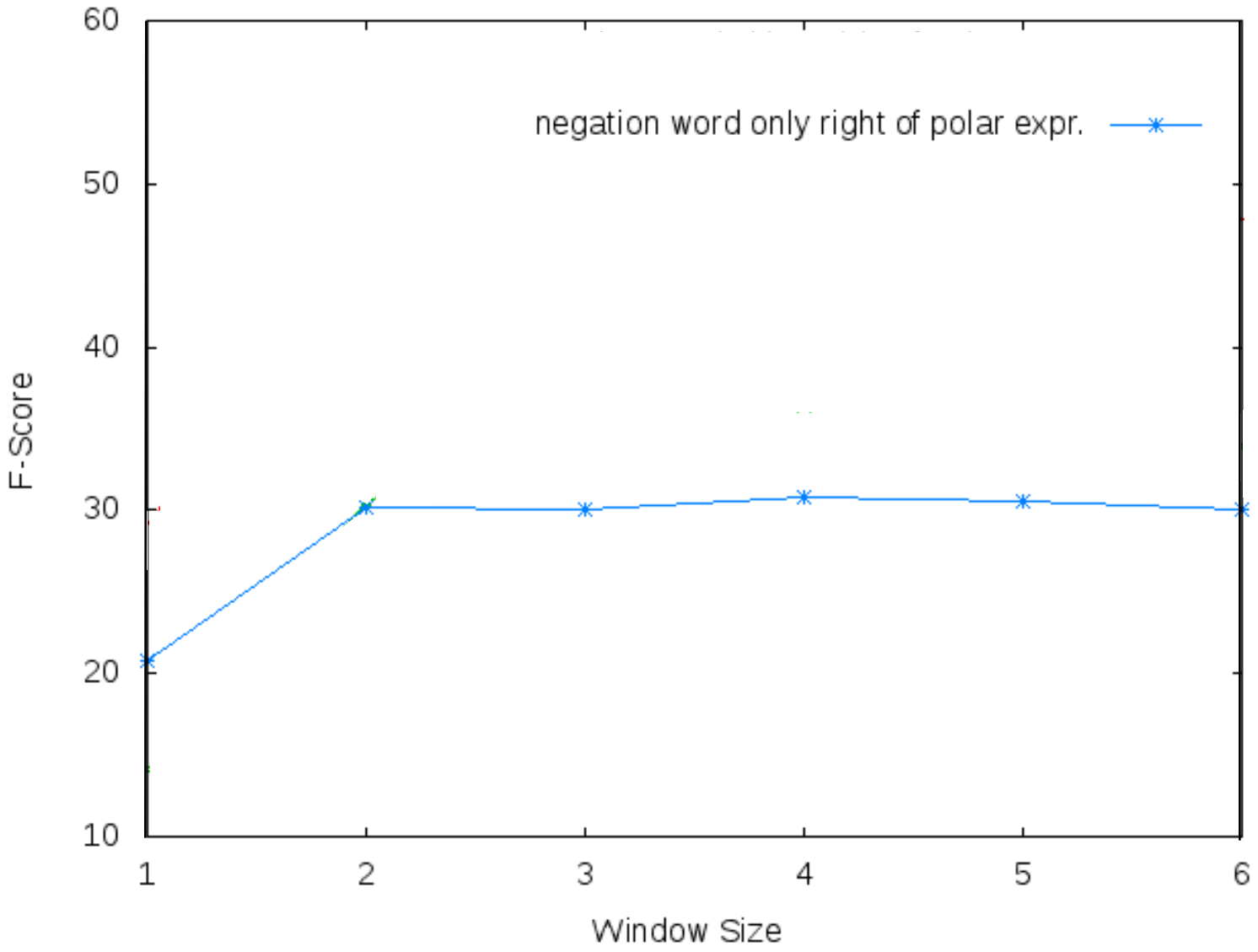
Different Configurations of Window Size



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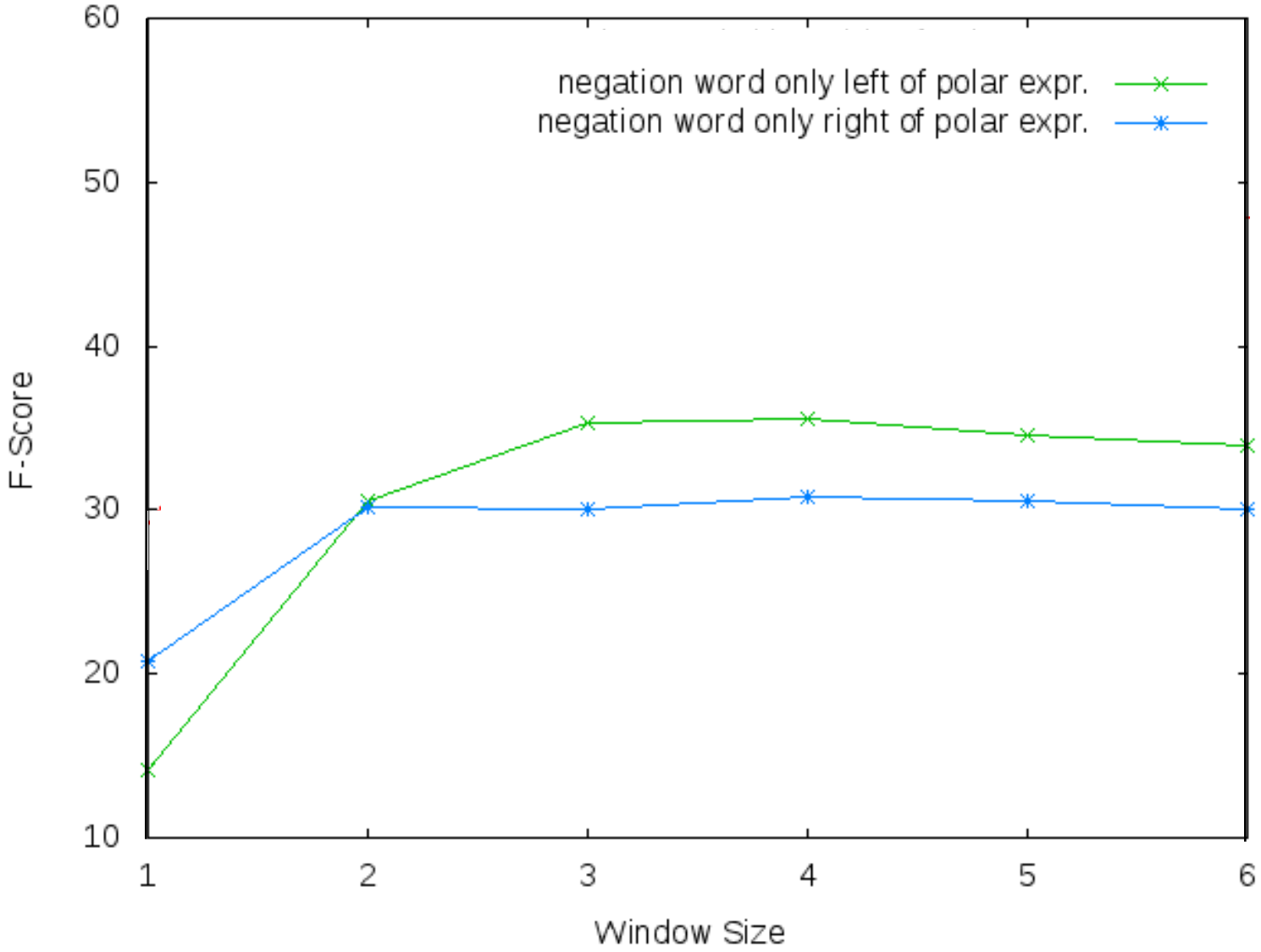

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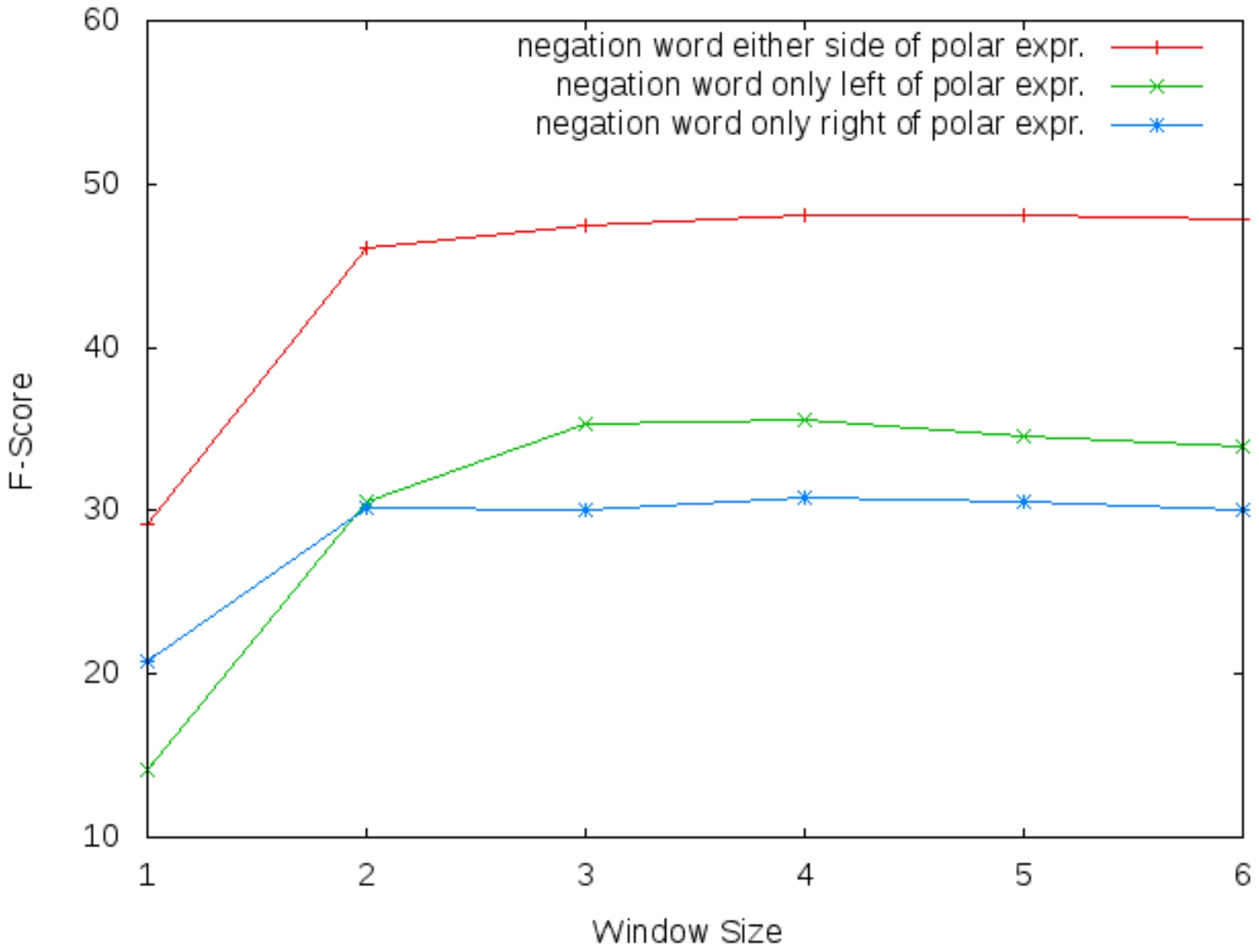

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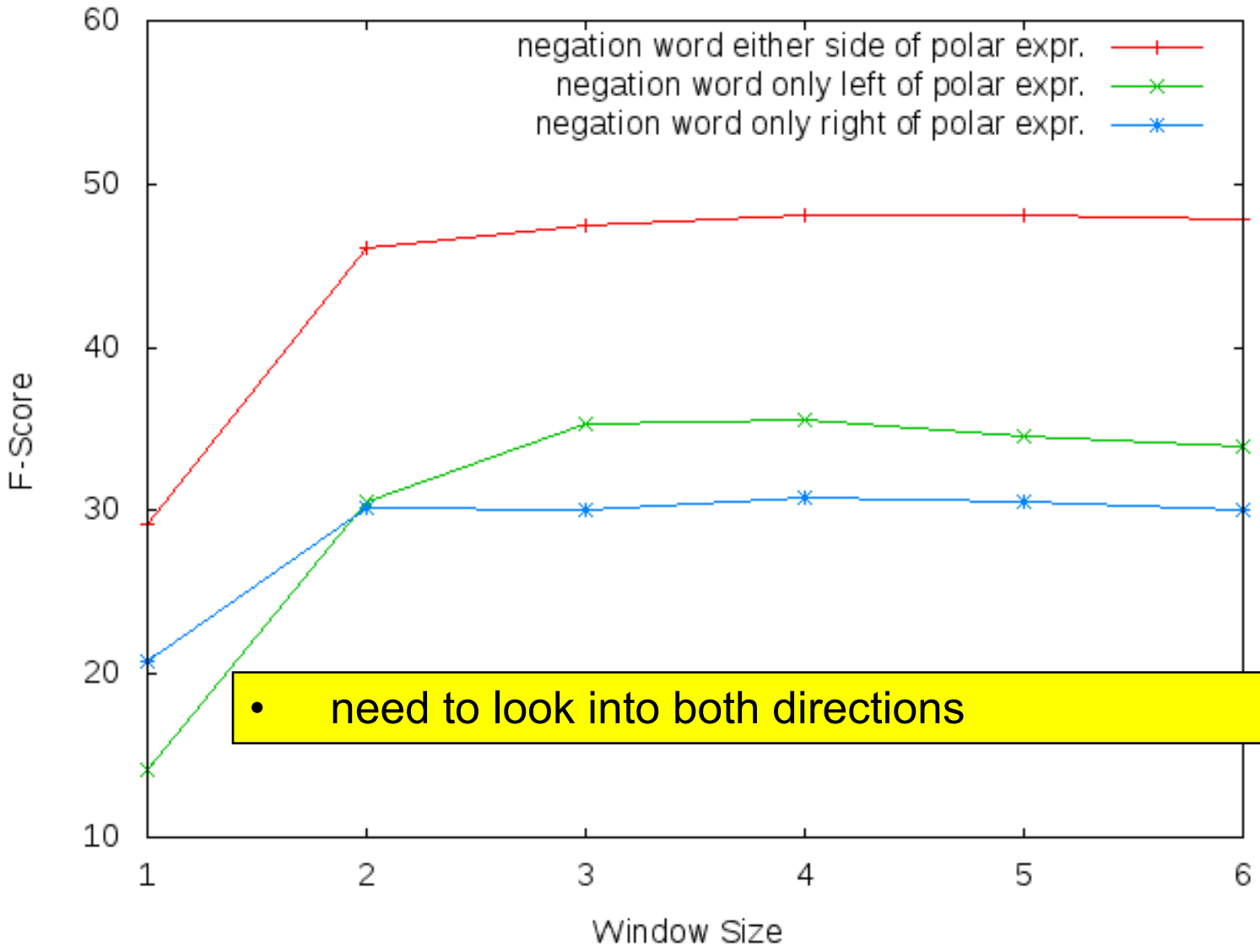

- need to look into both directions

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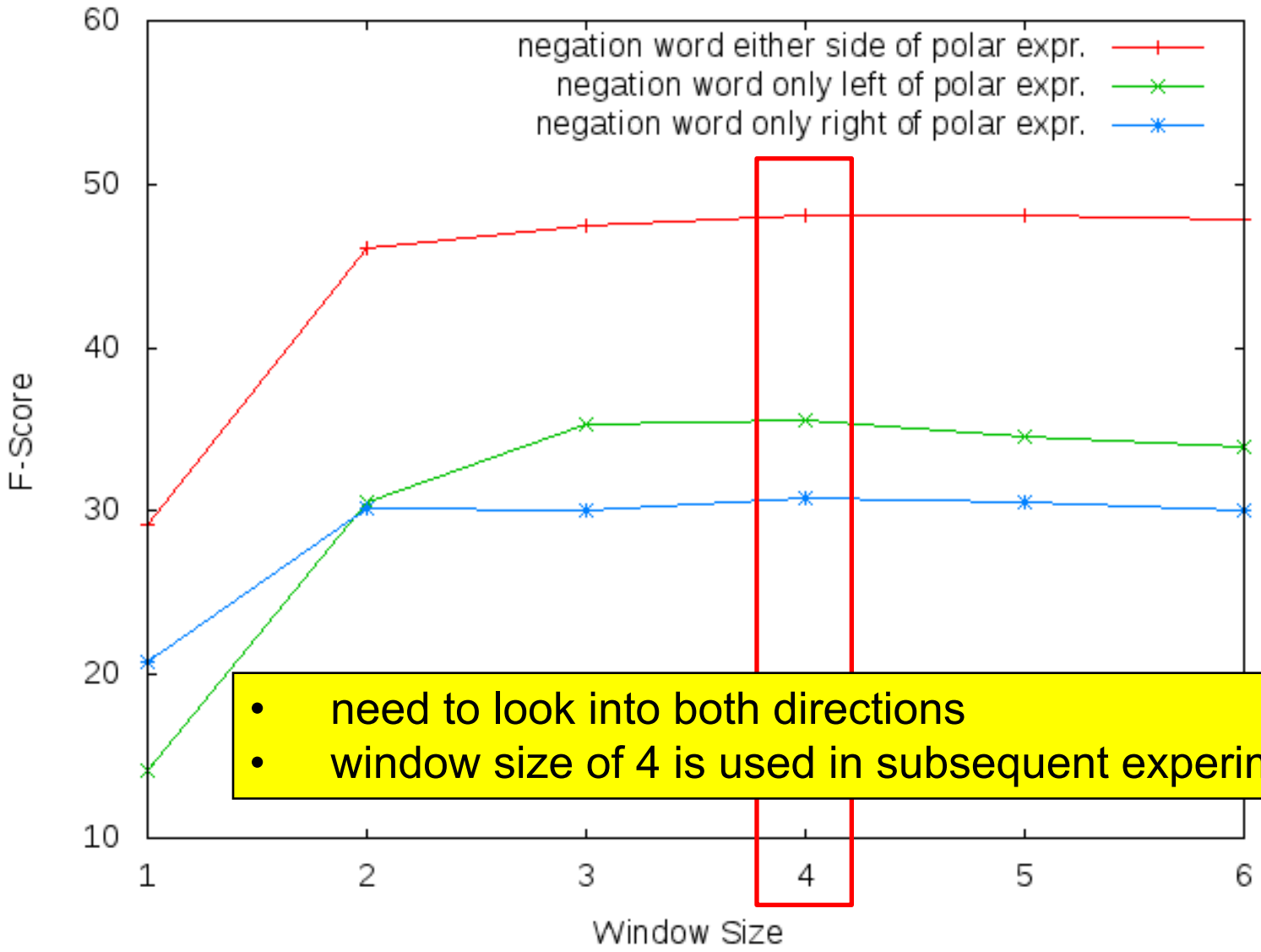

- need to look into both directions
- window size of 4 is used in subsequent experiments

Intrinsic Evaluation

Approach	Prec	Rec	F1

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baseline I: window-based	42.13	55.97	48.08
baseline II: clause-based	38.89	60.07	47.21

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There is no real difference between the two baselines.

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Notable improvement achieved by proposed method.

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baseline II: clause-based	38.89	60.07	47.21
proposed method	67.22	**60.45**	**63.65**
proposed method w/o normalization	71.54	34.70	46.73
proposed method w. simple verb scope: *obja*	**78.00**	43.44	55.98

Intrinsic Evaluation

Approach	Prec	Rec	F1
baseline I: window-based	42.13	55.97	48.08
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Most notably drop caused by omitting normalization of dependency parses.

Extrinsic Evaluation

- Incorporate the proposed negation model into a sentence-level polarity classifier.
- Rule-based classifier counting positive polar expressions (+1) and negative polar expressions (-1) from a polarity lexicon.
- Negation inverts the counts of negated polar expression.

Extrinsic Evaluation

Dataset			

Extrinsic Evaluation

Dataset			
HeiST [Haas, 2015]			
MLSA [Clematide, 2012]			

Extrinsic Evaluation

Dataset	**Classifier**		
HeiST [Haas, 2015]			
MLSA [Clematide, 2012]			

Extrinsic Evaluation

Dataset	**Classifier**		
HeiST [Haas, 2015]	w/o negation		
MLSA [Clematide, 2012]	w/o negation		

Extrinsic Evaluation

		F1	
Dataset	**Classifier**	**2 Classes**	**3 Classes**
HeiST [Haas, 2015]	w/o negation		
MLSA [Clematide, 2012]	w/o negation		

Extrinsic Evaluation

		F1	
Dataset	**Classifier**	**2 Classes**	**3 Classes**
HeiST [Haas, 2015]	w/o negation	58.4	50.8
MLSA [Clematide, 2012]	w/o negation	76.6	50.8

Extrinsic Evaluation

		F1	
Dataset	**Classifier**	**2 Classes**	**3 Classes**
HeiST [Haas, 2015]	w/o negation	58.4	50.8
	with negation	60.3	52.0
MLSA [Clematide, 2012]	w/o negation	76.6	50.8
	with negation	79.1	51.3

Extrinsic Evaluation

		F1	
Dataset	**Classifier**	**2 Classes**	**3 Classes**
HeiST [Haas, 2015]	w/o negation	58.4	50.8
	with negation	**60.3**	**52.0**
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Moderate but consistent improvement by proposed negation model on all datasets.

Outline of Talk

- Introduction
- Data & Annotation
- Method
- Experiments
- Conclusion

Conclusion

- First comprehensive study on German negation modelling for fine-grained sentiment analysis.
- Considers various types of negation words.
- Formulate rules for negation words with similar scope characteristics.
- Heavily exploit syntactic knowledge.
- Approach largely outperforms window-based and clause-based baselines.

Software tool and gold standard are publicly available under:

`https://github.com/artificial-max/polcla`

Thank You!

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BACK-UP SLIDES

What makes German more difficult?

- Ideally, we would employ semantic role labeling (SRL) for that task.
- SRL is too brittle for German.
- The negated expression is typically **A1** *(PropBank-terminology)* of a negation predicate (i.e. verb, noun, adj).
  - *Das [**ersparte** uns [viel Ärger$_{A1}$]$^{-}$]$^{+}$.*
  - *[[Die Schmerzen $_{A1}$]$^{-}$ **hören auf**]$^{+}$.*
  - *Ich [**bezweifle**, [dass es gut ist$_{A1}$]$^{+}$]$^{-}$.*

What makes German more difficult?

- Ideally, we would employ semantic role labeling (SRL) for that task.
- SRL is too brittle for German.
- Syntactic dependency relations are less conclusive.

  - *Das [**ersparte** uns [viel Ärger $_{\mathbf{obja}}$]$^{-}$]$^{+}$.*
  - *[[Die Schmerzen $_{\mathbf{subj}}$]$^{-}$ **hören auf**]$^{+}$.*
  - *Ich [**bezweifle**, [dass es gut ist $_{\mathbf{objc}}$]$^{+}$]$^{-}$.*

Intrinsic Evaluation

What happens if polar expressions and negation words are automatically identified?

Intrinsic Evaluation

What happens if polar expressions and negation words are automatically identified?

	F1	
Approach	**manual**	
baseline I: window-based	48.1	
baseline II: clause-based	47.2	
proposed method	63.7	

Intrinsic Evaluation

What happens if polar expressions and negation words are automatically identified?

	F1	
Approach	**manual**	**automatic**
baseline I: window-based	48.1	30.0
baseline II: clause-based	47.2	28.7
proposed method	63.7	40.6

Intrinsic Evaluation

What happens if polar expressions and negation words are automatically identified?

	F1	
Approach	**manual**	**automatic**
baseline I: window-based	48.1	30.0
baseline II: clause-based	47.2	28.7
proposed method	63.7	40.6

Intrinsic Evaluation

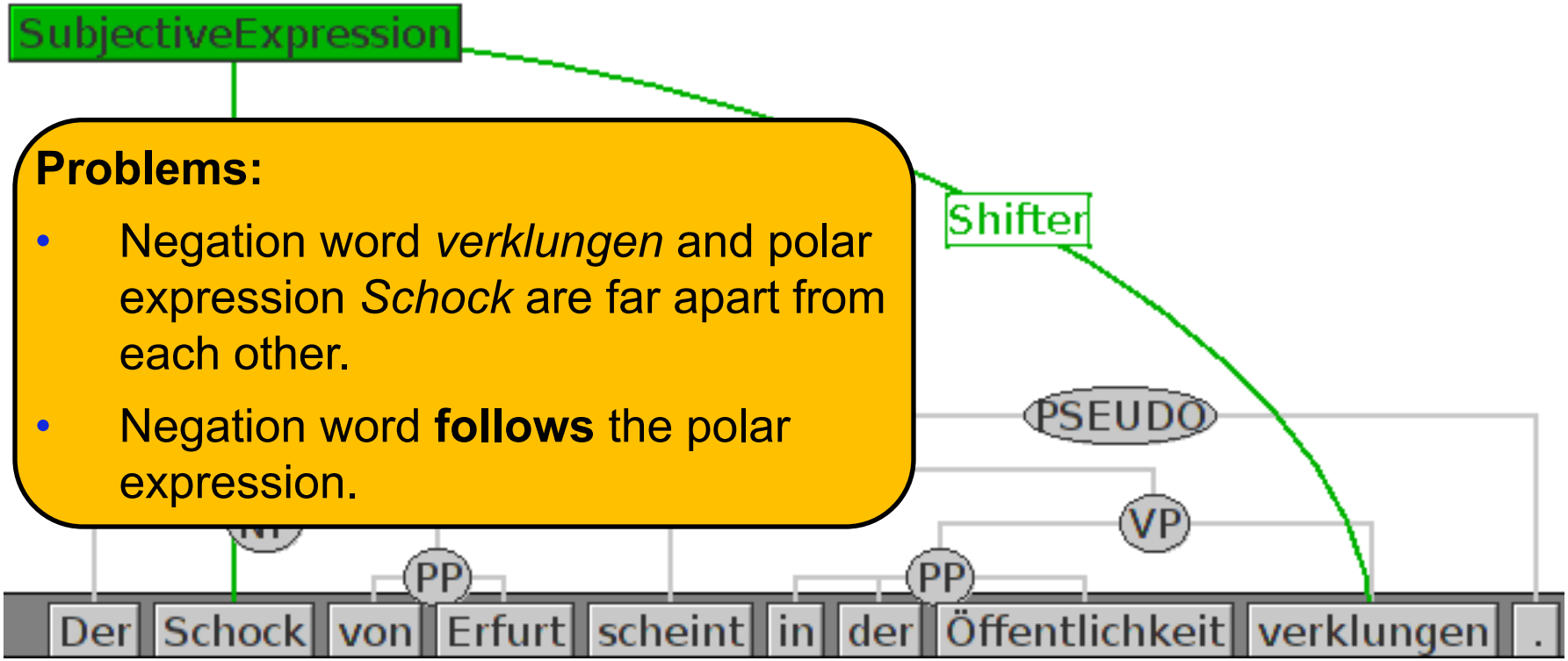
What happens if polar expressions and negation words are automatically identified?

	F1	
Approach	**manual**	**automatic**
baseline I: window-based	48.1	30.0
baseline II: clause-based	47.2	28.7
proposed method	63.7	40.6

+ +

Proposed method still largely outperforms the two baselines.

The Task Illustrated



Problems:

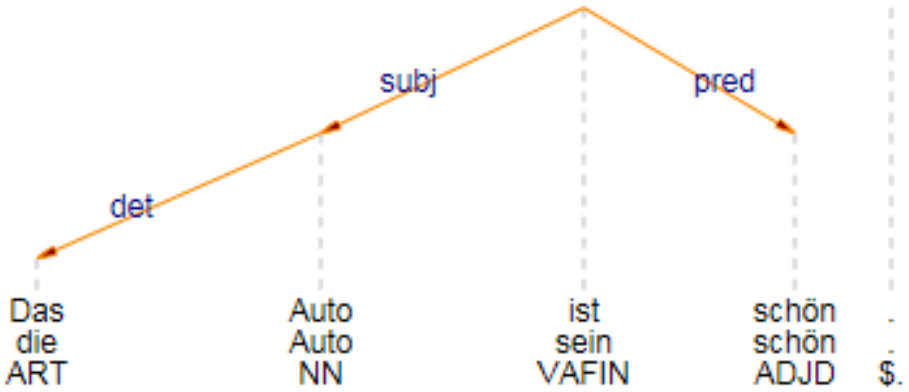
- Negation word *verklungen* and polar expression *Schock* are far apart from each other.
- Negation word **follows** the polar expression.

The shock of Erfurt seems to have faded away in the public.

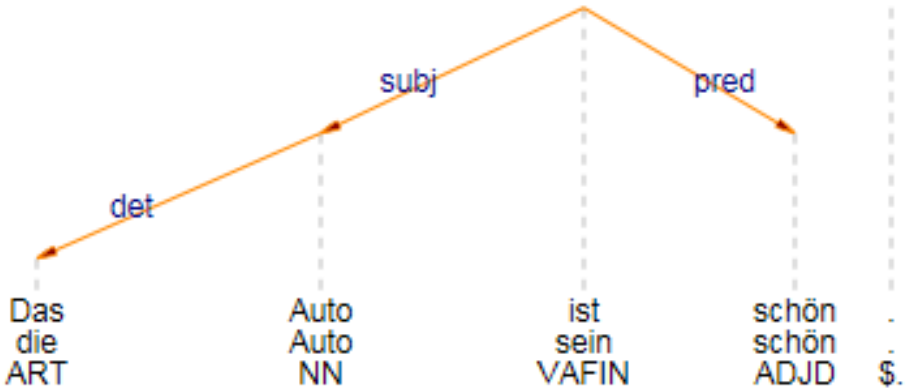
Why not learning this task?

- Only very few rules are necessary.
- Better linguistic insights into the problem by formulating rules.
- Learning would be affected by very limited amount of annotated data.

Dependency Parse Normalization – Predicative Adjectives

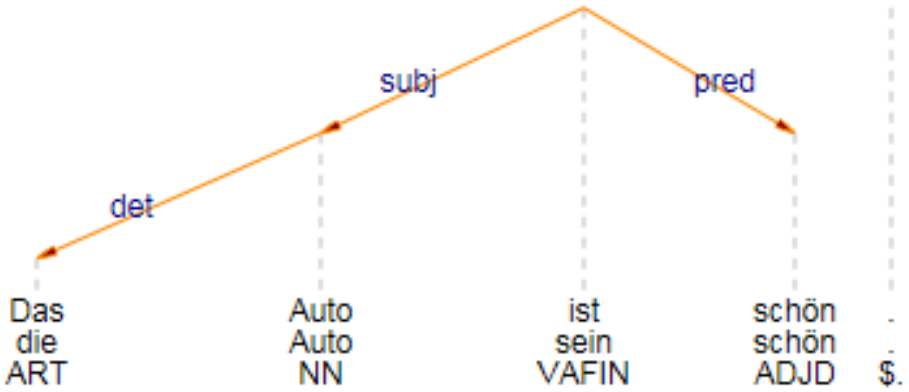


Dependency Parse Normalization – Predicative Adjectives



No direct relationship between ***schön*** and ***Auto***.

Dependency Parse Normalization – Predicative Adjectives



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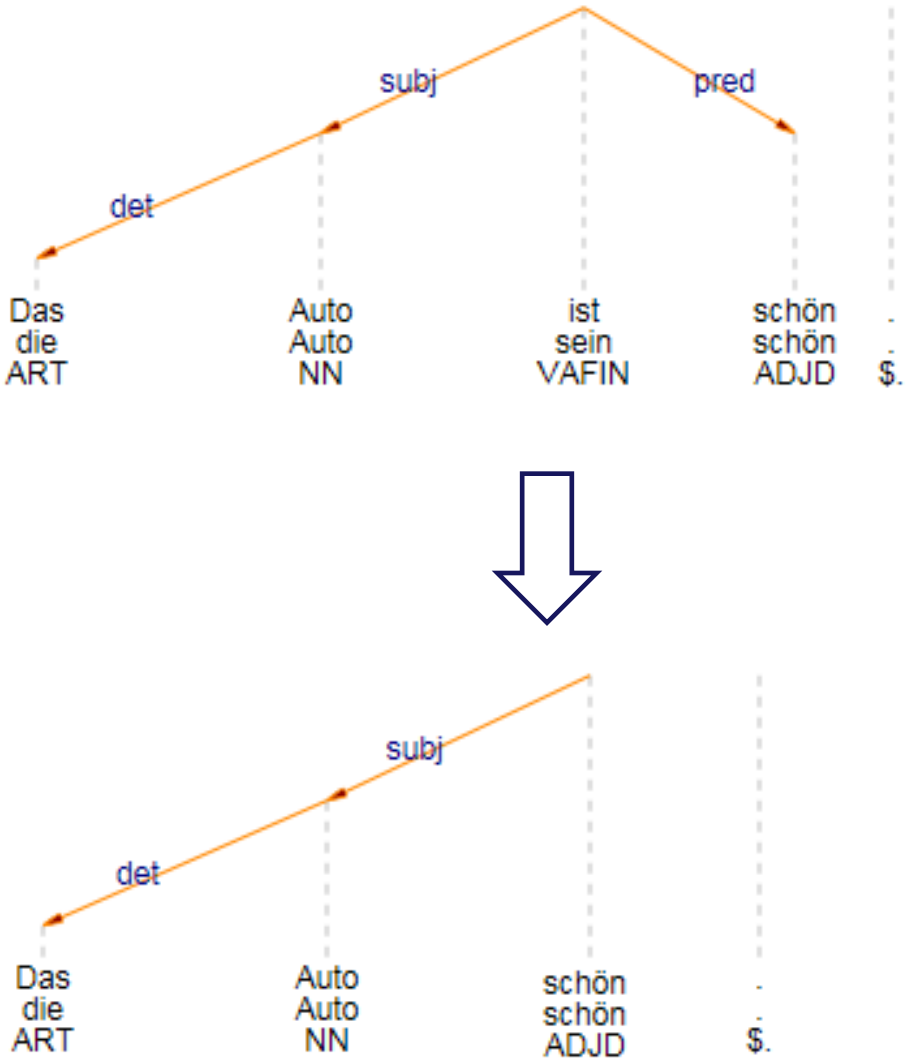
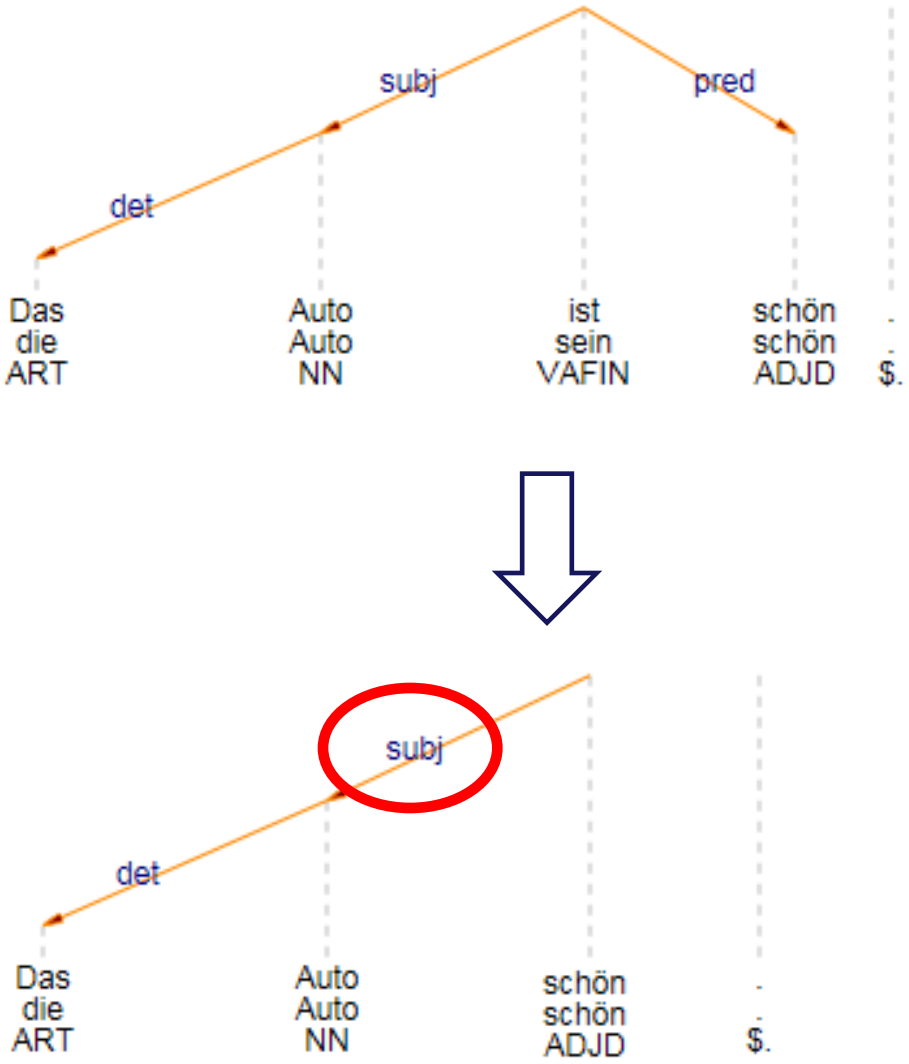
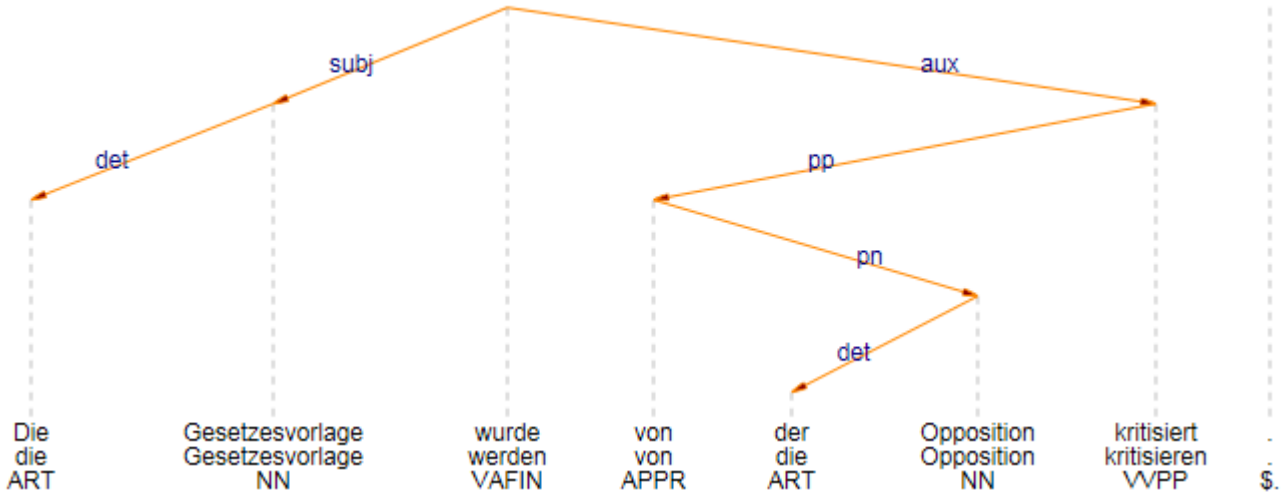


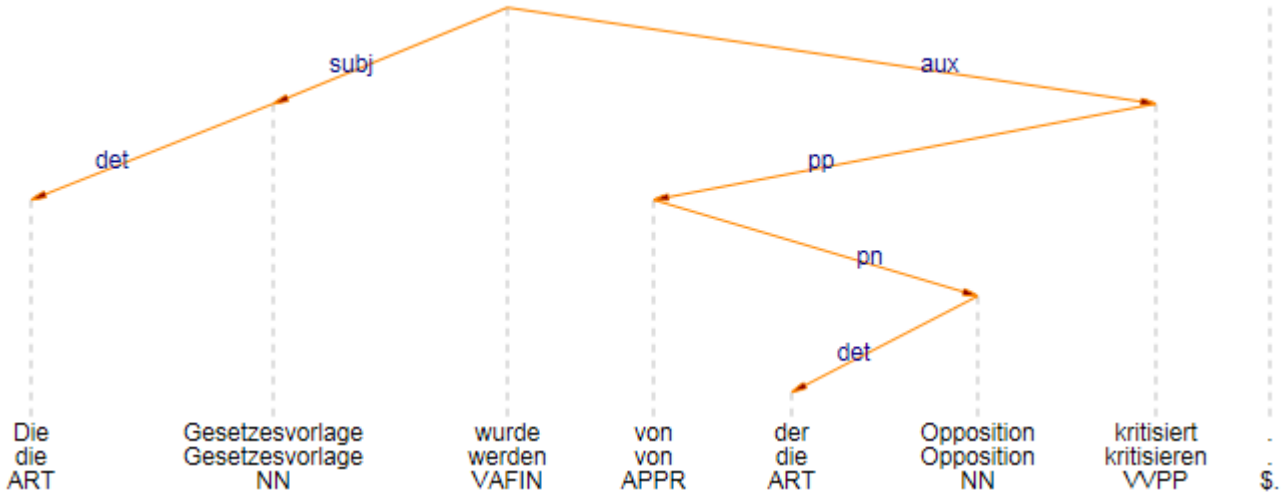
Dependency Parse Normalization – Predicative Adjectives



Dependency Parse Normalization – Passive Voice

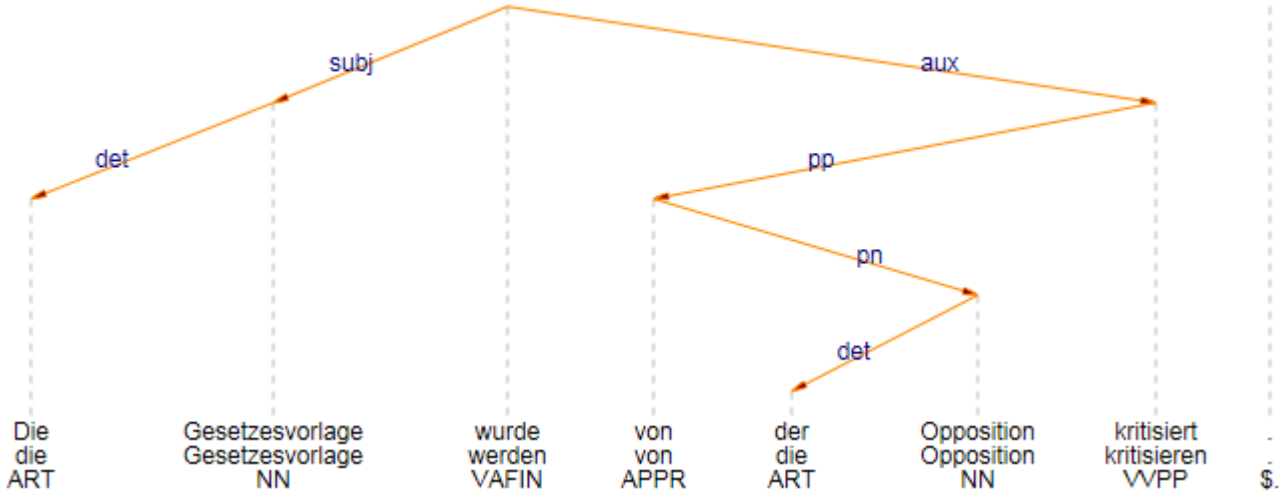


Dependency Parse Normalization – Passive Voice

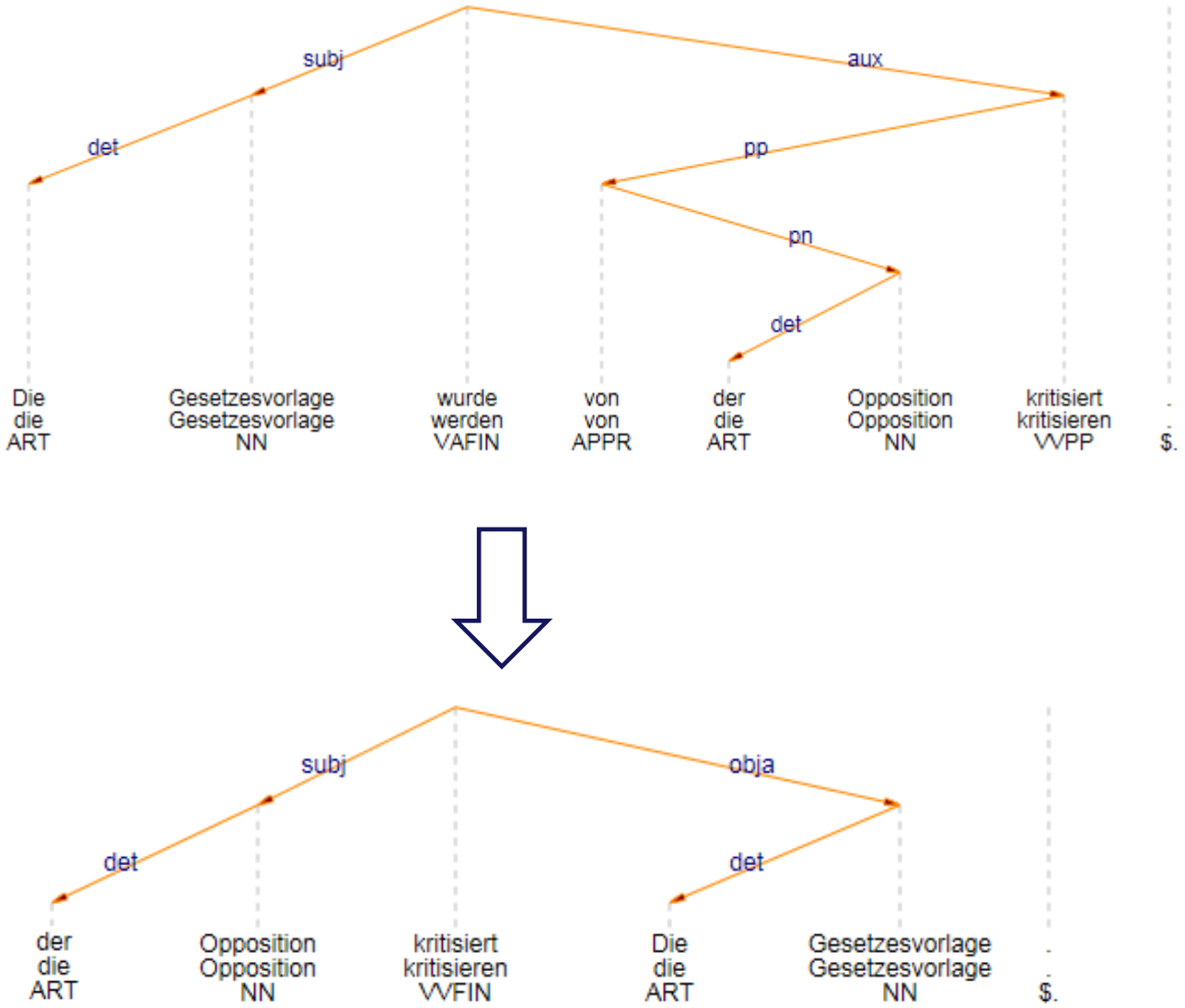


From a semantic point of view, active voice and passive voice are (more or less) identical → convert passive to active voice.

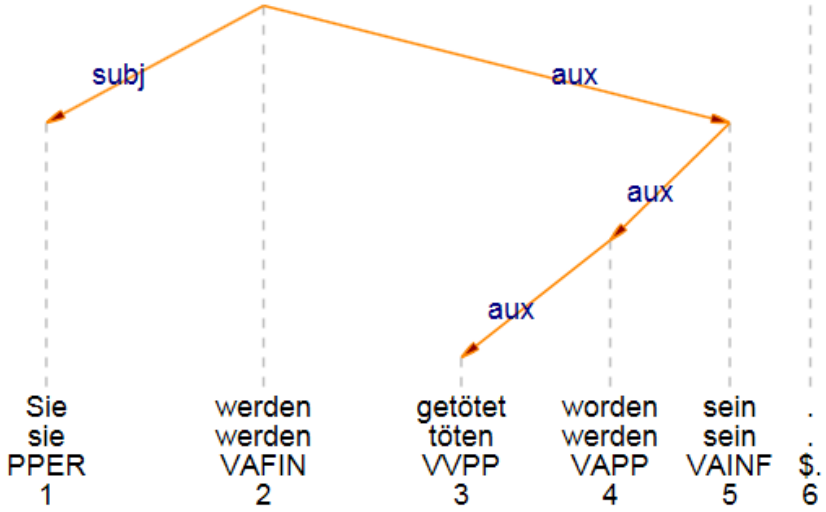
Dependency Parse Normalization – Passive Voice



Dependency Parse Normalization – Passive Voice



Dependency Parse Normalization – Finite Verbs with Many Auxiliaries



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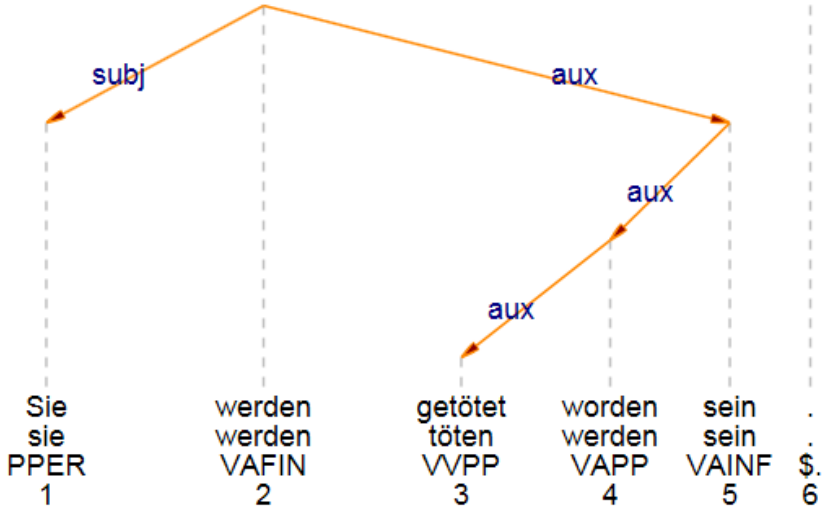
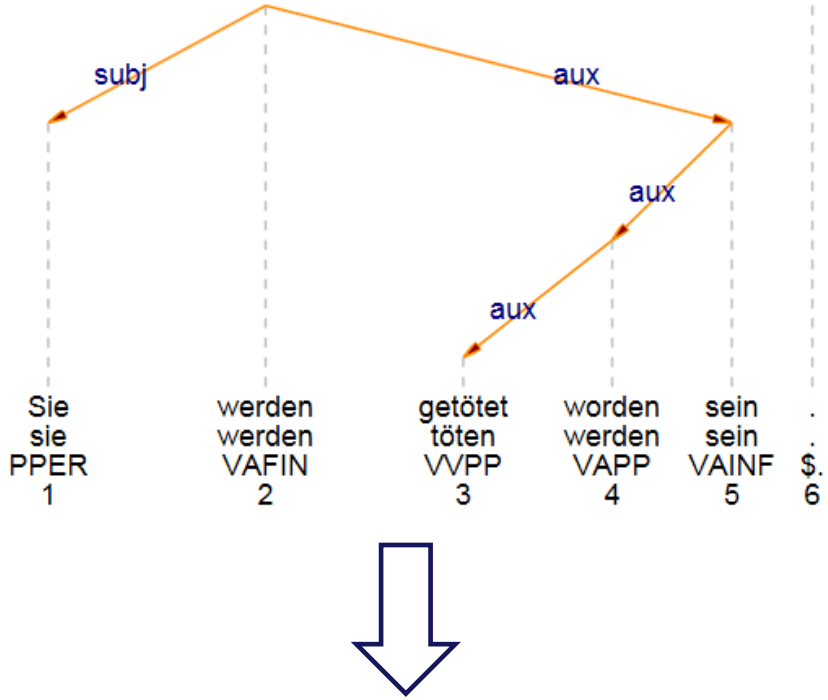


We only want direct syntactic relationships but the path from ***Sie*** to ***getötet*** is ↑**subj-**↓**aux-** ↓ **aux-** ↓ **aux**

Dependency Parse Normalization – Finite Verbs with Many Auxiliaries



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